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C02F 1/32

(52) UK CL (Edition Q)
H5R RBF RBU

(56) Documents Cited
GB 2252707 A WO 96/36565 A1 WO 94/19284 A1
US 5516492 A US 5069885 A

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INT CL[6] C02F 1/32
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(54) Abstract Title
Photo-oxidation instrument and water treatment method

(57) A photo-oxidation instrument, a water treatment system, and a method for water treatment thereby in a semiconductor device fabrication process are provided whereby water for use in the fabrication line is supplied after organic materials etc. in the initial water have been removed. The photo-oxidation instrument comprises: a UV lamp (20) for irradiating ultra violet radiation having a certain wavelength in order to oxidize organic materials contained in the water which is pre-treated; a photo-oxidation part (22) comprising the UV-lamp, and an inlet and an outlet for water flow; and a catalyzing part (30) provided on an inside wall of the photo-oxidation part in order to activate oxidation of the organic materials during irradiation of the UV radiation having a certain wavelength.

FIG. 4

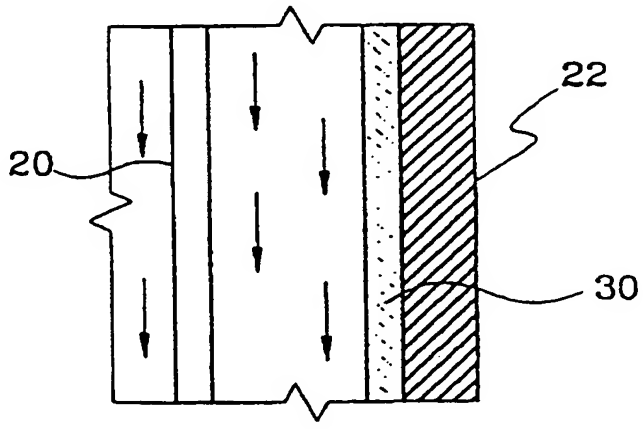

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FIG. 1
(PRIOR ART)

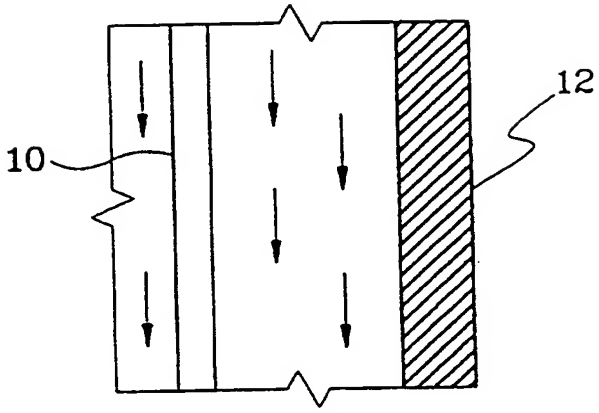

FIG. 2

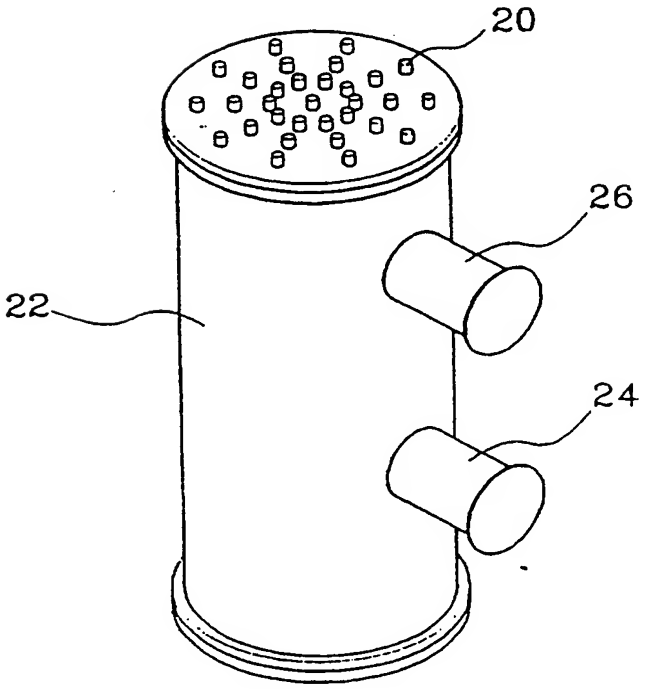

FIG. 3

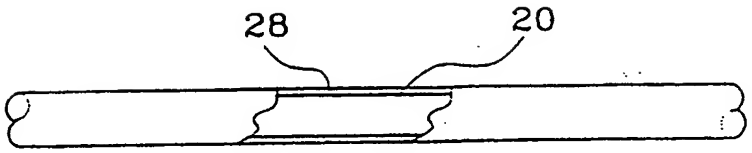

FIG. 4

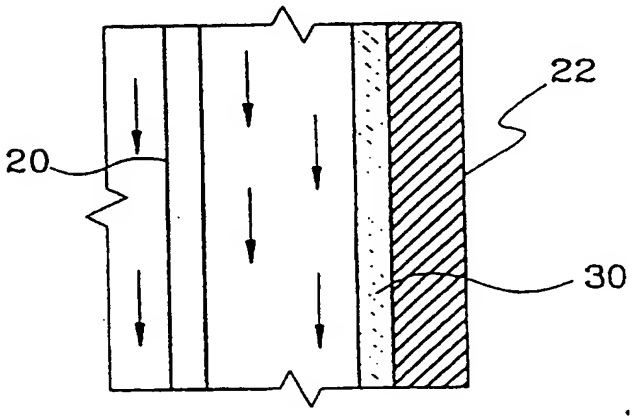

FIG. 5

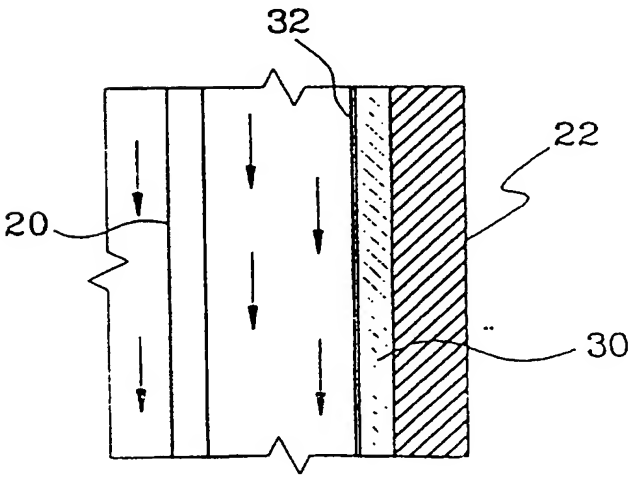

FIG. 6

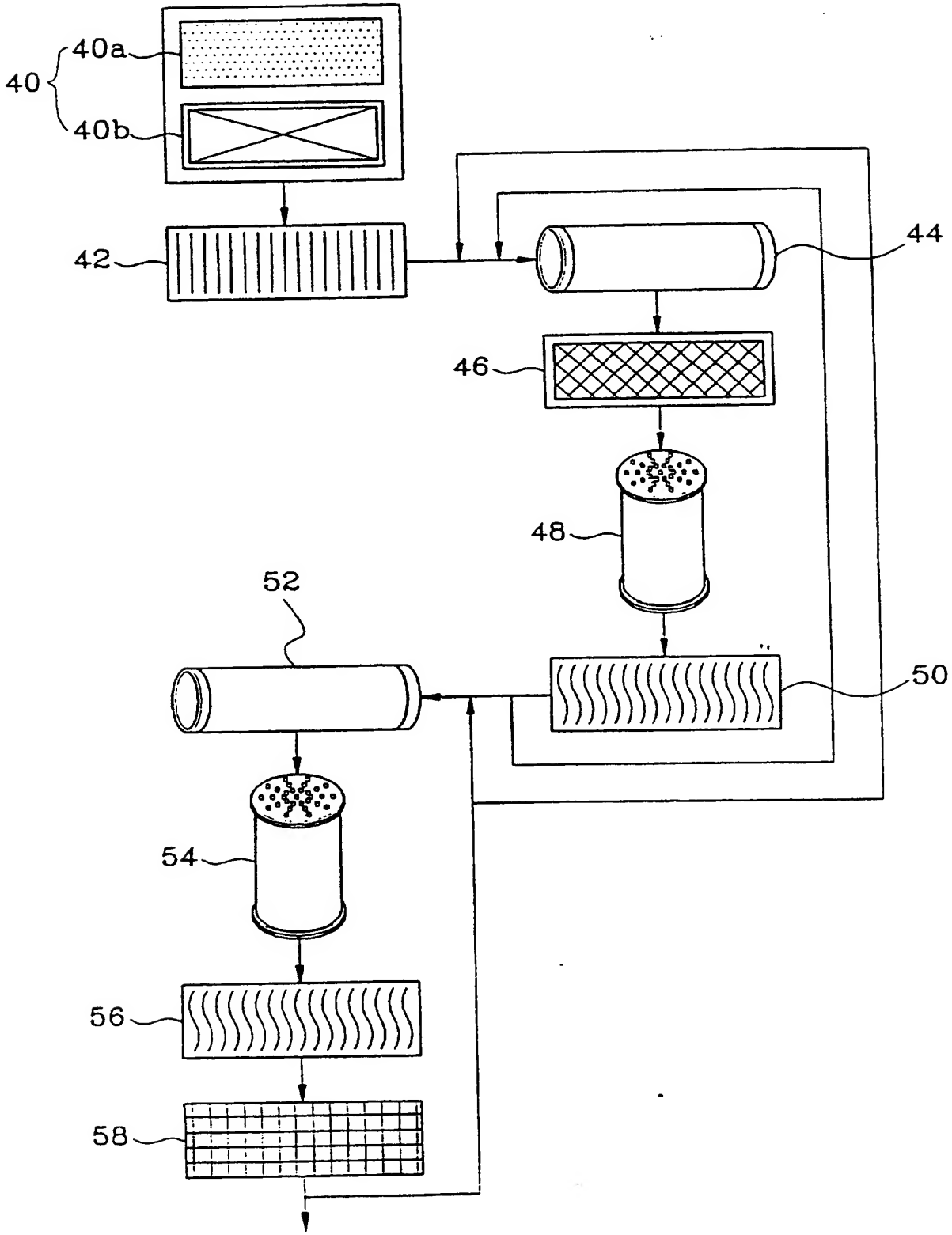

FIG. 7

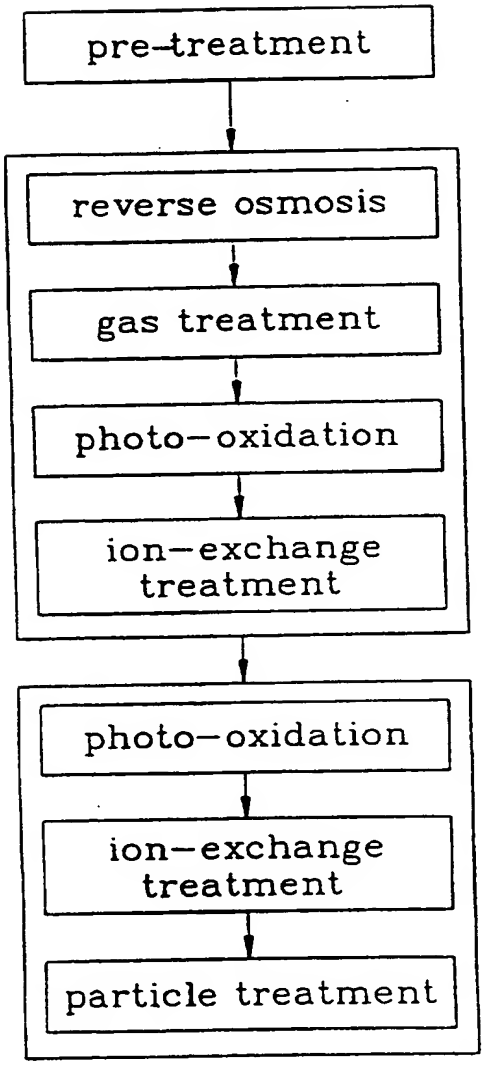
pre-treatment
reverse osmosis
gas treatment
photo-oxidation
ion-exchange treatment
photo-oxidation
ion-exchange treatment
particle treatment

PHOTO-OXIDATION INSTRUMENT FOR A WATER-TREATMENT SYSTEM IN A SEMICONDUCTOR DEVICE FABRICATION PROCESS, A WATER TREATMENT SYSTEM, AND A METHOD FOR WATER TREATMENT THEREBY

The present invention relates to a system for treating water used in a semiconductor device fabrication process, and more particularly, to a photo-oxidation instrument equipped with a catalysing-part for activating the oxidation of organic material contained in the water used in the semiconductor device fabrication process during irradiation of UV (Ultra Violet) radiation having a certain wavelength, a water-treatment system, and a method for water-treatment thereby.

Generally, a large amount of water is used in a semiconductor device fabrication process in order to carry out a cleaning process for semiconductor substrates, etc.

Here, the water is used in the semiconductor device fabrication process after treating a city water or used water used in the fabrication line by a water-treatment system.

The water used in the semiconductor device fabrication process is a deionized water, wherein floating particles, organic materials, and ions, etc. therein are completely removed.

In addition, the deionized water is generally prepared by using pre-treatment such as precipitation, reverse osmotic pressure, a photo-oxidation treatment using UV, and an ion-exchange treatment using ion-exchange.

The photo-oxidation treatment is to oxidise the organic materials contained in the water passing through the pre-treatment, and then, the oxidised organic materials go to the following ion-exchange treatment.

In the above photo-oxidation, a UV-lamp is used for irradiating with UV radiation having a certain wavelength.

Referring to Fig. 1, the conventional photo-oxidation instrument comprises UV-lamp 10 and a photo-oxidation part 12 including a line for water flow.

Here, by the photo-oxidation treatment using the photo-oxidation instrument, micro-organic materials, which were not removed through the pre-treatment, are treated.

That is, the organic materials are treated by irradiating with UV radiation having a certain wavelength while flowing water through the photo-oxidation part 12.

As a result, the organic materials contained in the water react with the UV radiation having a certain wavelength (photo-decomposition) so as to be oxidised into organic acid ions of composition, such as CO_2 or HCO_3, and then in the following ion-exchange treatment, the organic materials are removed by using H^+ or OH^-.

However, in conventional photo-oxidation employing the photo-oxidation instrument constructed as above, it is not easy to oxidise the aromatic organic materials which are relatively stable chemical compounds.

That is, usage of only UV-irradiation cannot decompose the aromatic organic materials into the organic acid ions as above.

Accordingly, the aromatic organic materials are still contained in the water.

Therefore, the water containing the aromatic organic materials is supplied into the semiconductor device fabrication process, and the introduction of the organic materials into the fabrication process line results in production failure.

Especially, since the more recent semiconductor device fabrication processes control the organic materials contained in the water to ppb (parts per billion), the supply of the water containing aromatic organic materials causes significant production failure.

In addition, a water-treatment system continues to be operated in order to treat the water thereby resulting in the decrease of the productivity.

That is, in the conventional water treatment system with the above photo-oxidation instrument, organic materials contained in the water are not completely treated so that the reliability and the production yield of the semiconductor devices deteriorate.

The present invention is directed to providing a photo-oxidation instrument in a semiconductor device fabrication process, a water treatment system equipped with the photo-oxidation instrument, and a method for water treatment thereby, which substantially obviates one or

more of the problems due to the disadvantages and the limitations of the related art.

One object of the present invention is to improve reliability and productivity of semiconductor devices by supplying water into the semiconductor device fabrication line after the organic materials in the water are completely removed through the water treatment system.

According to a first aspect of the present invention, a photo-oxidation instrument of a water treatment system in a semiconductor device fabrication process comprises : a UV lamp for irradiating ultra violet radiation having a certain wavelength in order to oxidise organic materials contained in the water which is pre-treated; a photo-oxidation part comprising the UV-lamp, and an inlet and an outlet for water flow; and a catalysing part provided on an inside wall of the photo-oxidation part in order to activate oxidation of the organic materials during irradiation of the UV radiation having a certain wavelength.

The UV lamp preferably irradiates UV radiation of 185 nm wavelength or 254 nm wavelength.

The photo-oxidation part preferably comprises a plurality of UV lamps.

Preferably, the catalysing part is made of TiO_2, the catalysing part is provided on the inside wall of the photo-oxidation part with a certain distance between parts thereof, and the surface of the catalysing part is coated with polymer film.

According to a second aspect of the present invention, a water-treatment system comprises : a pre-treatment unit comprising a sand filter for receiving water and precipitating the floating materials contained therein ; a reverse osmosis unit comprising a filter for receiving the water which is pre-treated and removing the ions and the organic materials contained in the water by using reverse osmotic pressure ; a gas treatment unit comprising a vacuum filter for receiving the water from which ions and organic materials are removed, and removing O_2 or CO_2, etc, gases contained in the water by using a vacuum, a first photo-oxidation unit comprising a UV lamp for irradiating UV radiation, a photo-oxidation part containing a plurality of UV lamps, and a catalysing part made of TiO_2 and provided on an inside wall of the photo-oxidation part for activating the oxidation of organic materials, the first photo-oxidation unit receiving the water passing through the gas removal unit and oxidising the organic materials contained in the water by using UV radiation of a certain wavelength ; a first ion-exchange unit comprising an ion-exchange resin for receiving the water containing the oxidised organic materials from the first photo-oxidation unit and removing the ions contained in the water by using ion-exchange ; a second photo-oxidation unit comprising a UV lamp for irradiating UV radiation, a photo-oxidation part containing a plurality of UV lamps, and a catalysing part made of TiO_2 and provided on the inside wall of the photo-oxidation part for activating the oxidation of organic materials, the second photo oxidation unit receiving the water passing through the first ion-exchange unit and oxidising the organic materials contained in the water by using UV radiation of a certain wavelength ; a second ion-exchange unit comprising an ion-exchange resin for receiving the water containing the oxidised organic materials from the second photo-oxidation unit and removing the ions contained in the water by using ion-exchange ; and a particle treatment unit comprising a filter

for receiving the water passing through the ion-exchange unit and filtering the particles remaining in the water.

The pre-treatment unit may further comprise an activated carbon filter for improving the muddiness of water.

Preferably, the system further comprises a first temporary storage tank for temporarily storing the water between the reverse osmosis unit and the gas treatment unit ; and a second temporary storage tank for temporarily storing the water between the first ion-exchange unit and the second photo-oxidation unit.

Preferably, the first photo-oxidation unit comprises a UV-lamp for irradiating UV radiation of 185 nm wavelength or 254 nm wavelength.

Preferably, the second photo-oxidation unit comprises a UV-lamp for irradiating UV radiation of 185nm wavelength.

According to a third aspect of the present invention, a water treatment method in a semiconductor device fabrication process comprises the steps of : a) pre-treating the water for improving precipitation of the floating materials contained in the water, and the muddiness of the water ; b) carrying out a first water treatment comprising reverse osmosis treatment for removing organic materials and ions contained in the received water, gas treatment for removing gas such as O_2 or CO_2 etc., photo-oxidation treatment for irradiating the water with a certain wavelength of UV radiation and using a catalyst of TiO_2, and ion-exchange treatment by ion exchange, the above treatment steps being carried out in sequence such that the water passing through the pre-treatment is received in the first water treatment and the organic materials

or ions in the water are treated ; and c) carrying out a second water treatment comprising photo-oxidation treatment for irradiating the water with a certain wavelength of UV radiation and using a catalyst of TiO_2, ion-exchange treatment using ion-exchange, and particle treatment for removing particles, the above steps being carried out in sequence such that the water passing through the first water treatment is received in the second water treatment and the organic materials or ions in the water are treated.

Preferably, in the first water treatment, the wavelength of the UV radiation is 185 nm or 254 nm.

Preferably, in the second water treatment, the wavelength of the UV radiation is 185 nm.

It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

Embodiments of the present invention will now be described by way of example only, with reference to the accompanying drawings, in which:

Figure 1 illustrates one part of a conventional photo-oxidation instrument of a water treatment system in a semiconductor device fabrication process ;

Figure 2 illustrates an embodiment of the photo-oxidation instrument of the water treatment system in a semiconductor device fabrication process according to the present invention :

Figure 3 illustrates a UV-lamp provided in the system of Fig. 2 ;

Figures 4 and 5 illustrate one part of the photo-oxidation instrument of the water treatment system in the semiconductor device fabrication process according to the present invention ;

Figure 6 illustrates an embodiment of the water treatment system in the semiconductor device fabrication process according to the present invention ; and

Figure 7 illustrates an embodiment of the method for water treatment in the semiconductor device fabrication process according to the present invention.

First, referring to Fig. 2 illustrating a photo-oxidation instrument, there is provided a UV-lamp 20 for irradiating a certain wavelength of UV radiation, and a photo-oxidation part 22 for containing the UV-lamp 20 and an inlet 24 and an outlet 26 for the water.

Here, the UV-lamp, as shown in Fig. 3, is coated with quartz 28.

The UV lamp 20 of the present invention can be a UV lamp which irradiates 185 nm wavelength UV radiation, or a UV lamp which irradiates 254 nm wavelength UV radiation.

In addition, a plurality of UV lamps 20 are provided in an inside wall of the photo-oxidation part 22.

The photo-oxidation part 22 irradiates a certain wavelength of UV radiation on the water by using the UV-lamp 20 provided therein as above, and allows the organic materials in the water to react with the UV radiation, that is, by photo decomposition so as to activate the oxidation of the organic materials.

A catalysing part 30 of the photo-oxidation instrument is made of TiO_2.

Accordingly, aromatic organic materials existing as stable chemical compounds can be oxidised by the present invention employing UV irradiation by the UV lamp 20 and the catalysing part 30 made of TiO_2 in order to oxidise the organic materials in the water.

Activation of the oxidation of the organic materials is increased when a certain wavelength of UV radiation is irradiated on the organic materials which are attached on the surface of the catalysing part 30 made of TiO_2.

In addition, the catalysing part 30 is formed in an inside wall of the photo-oxidation part 22 with a plurality of the catalysing parts 30 spaced apart from each other, which in this embodiment are made of TiO_2.

As shown in Fig. 5, the catalysing part 30 of TiO_2 is coated with a polymer film 32.

The coating of the polymer film 32 on the catalysing part 30 is intended to prevent the recontamination of the water due to the abrasion of the catalysing part 30 by the water or the irradiation of the UV radiation.

Recent semiconductor device fabrication processes controlling contaminants in the water to ppb is very sensitive to contamination by micro quantities of contaminants, especially here due to the contamination of the water by the catalysing part 30 and therefore the coating of polymer film 32 is necessary.

A water treatment system having the photo-oxidation instrument of the present invention is illustrated in Fig. 6.

First, it comprises a pre-treatment unit 40 having a sand filter 40a for receiving the initial water and precipitating floating materials contained in the water, and an activated carbon filter 40b for improving the muddiness of the water by using activated carbon.

The system further comprises a reverse osmosis unit 42 having a filter for receiving the water passing through the pre-treatment and removing the ions and organic materials in the water by using reverse osmotic pressure.

A first temporary storage tank 44 is provided for temporarily storing the water passing through the reverse osmosis unit 42.

In addition there is provided a gas treatment unit 46 having a vacuum filter for receiving the water from which ions and organic materials are removed, and removing gas such as O_2 or CO_2 contained in the water by using a vacuum.

In addition, according to the present invention, the organic materials in the water are oxidised by using a certain wavelength of UV radiation after receiving the water from which gases are removed.

That is, the organic materials are oxidised by using a first photo-oxidation unit 48 comprising a UV lamp 20 to irradiate UV radiation, a photo-oxidation part 22 containing a plurality of the UV lamps 20, and a catalysing part 30 made of TiO_2 for activating oxidation of the organic materials and provided in the inside wall of the photo-oxidation part 22.

The first photo-oxidation unit 48 uses a UV-lamp 20 for irradiating UV radiation of 185 nm wavelength or 254 nm wavelength.

That is, the present invention can employ a 185 nm wavelength UV lamp or a 254 nm wavelength UV lamp, or it can have both of them installed in sequence.

There is provided a first ion-exchange unit 50 having an ion-exchange resin for receiving the water containing the oxidised organic materials from the first photo-oxidation unit and removing the organic materials in the water by using ion-exchange.

Here, there is further provided a second temporary storage tank 52 for temporarily storing the water passing through the first ion-exchange unit 50.

Then the organic materials in the water passing through the ion-exchange unit 50 are oxidised by using a certain wavelength of UV radiation.

That is, the organic materials are oxidised by using a second photo-oxidation unit 54 comprising a UV lamp 20 for irradiating UV radiation, a photo-oxidation part 22 for containing a plurality of UV lamps 20, and a catalysing part 30 made of TiO_2 for activating the oxidation of the organic materials and provided in the inside wall of the photo-oxidation part 22.

The second photo-oxidation unit 54 can employ a UV lamp of 185 nm wavelength.

In addition, there is provided a second ion-exchange unit 56 having an ion-exchange resin, for receiving the water containing the oxidised organic materials from the second photo-oxidation unit, and removing the organic materials in the water by using ion-exchange.

In addition, there is provided a particle treatment unit 58 having a filter, for receiving the water passing through the ion-exchange unit 56 and filtering off the particles remaining in the water.

A method of water treatment using the above water treatment system is illustrated by Fig. 7, and comprises a first water treatment comprising pre-treatment, reverse osmosis, photo-oxidation, and ion exchange, and a second water treatment comprising photo-oxidation, ion-exchange, and particle treatment.

Accordingly, the water passing through the above treatment is supplied into the semiconductor device fabrication process.

The photo-oxidation units 48, 54 of the water-treatment system have a catalyzing part 30 installed in the photo-oxidation part 22 respectively.

Accordingly, aromatic organic materials, which are not treated by usage of only UV radiation, can be oxidised easily.

That is, according to the present invention, a water-treatment system having the photo-oxidation units 48, 54 is employed in a semiconductor device fabrication line, wherein contaminants in the water used in the fabrication line are controlled to ppb, thereby preventing production failure due to the water.

Hereinafter, a detailed description of the substantial embodiment of the present invention is made.

First, by using pre-treatment unit 40 comprising a sand filter 40a and an activated carbon filter 40b, floating materials in the water are precipitated, and the muddiness thereof is improved.

Here, pre-treatment of the water by using the pre-treatment unit 40 is intended to prevent overloading in the following treatment step for the water.

Then, organic materials and ions contained in the water passing through the pre-treatment are removed by using reverse osmosis.

Here, in the reverse osmosis, salt solution such as NaCl is separated from the water by using a semipermeable membrane and water pressure, which uses the fact that the flow of the water, solvent, is directed to the low concentration.

The water passing through the reverse osmosis is stored in the first temporary storage tank.

The first temporary storage tank can store water which is used in the semiconductor device fabrication process and recirculated, as well as water passing through the reverse osmosis as described above.

The recirculated water passes through the following water treatment, and is used again.

Returning to the water-treatment, the water, which is reverse osmosis treated, passes through a vacuum filter so as to remove gas such as O_2 or CO_2 etc. contained in the water.

Then, the water, which is gas-treated, goes through photo-oxidation so as to oxidize the organic materials in the water.

Here, by the photo-oxidation of the present invention, 185 nm wavelength UV radiation is used so as to oxidize the organic materials in the water, and the catalyzing part 30 is made of TiO_2.

The photo-oxidation uses 254 nm wavelength UV radiation as well as 185 nm wavelength UV radiation.

The UV irradiation using the catalyzing part 30 made of TiO_2 oxidizes aromatic organic materials which are not easily oxidized in the conventional method.

In addition, the wavelength conditions of the UV lamp 20 are adjustable by using the catalyzing part 30 in the above photo-oxidation.

Then, the water, which is oxidized by the above photo-oxidation, goes to the ion-exchange treatment using ion-exchange resin. That is, organic materials in the water are removed by using H^+ or OH^-, etc.

Then, the water passing through the ion-exchange treatment is stored in a second temporary storage tank 44.

The second temporary storage tank can store water which is used in the semiconductor device fabrication process and recirculated, as well as the water passing through the ion-treatment as described above.

Sequentially, the water is again photo-oxidized so as to oxidize the organic materials contained in the water such that contaminants in the water can be controlled to ppb.

Here, the organic materials contained in the water are oxidized by irradiating 185 nm wavelength UV radiation and using the catalyzing part 30 made of TiO_2.

In addition, the water, which is oxidized by the photo-oxidation, goes to ion-exchange treatment using ion-exchange resin. Organic materials of the water are removed by using H^+ or OH^-, etc.

The organic materials and ions, contained in the water are removed by the ion-exchange treatment.

In addition, after removing the particles etc. contained in the water, the water is supplied to the semiconductor device fabrication process.

According to the present invention, the photo-oxidation treatment using the catalyzing part 30 made of TiO_2 oxidizes aromatic organic materials in the water so that it can be used in the fabrication process, wherein contaminants in the water are controlled to ppb.

The water is supplied into the fabrication process after aromatic organic materials have been completely removed so that production failure due to the aromatic organic materials contained in the water is prevented in advance.

In addition, the productivity and the reliability of the semiconductor devices are improved by the water-treatment system of the present invention by treating the contaminants, such as organic materials in the water completely.

Still further, while embodiments of the present invention have been described in detail, it should be understood that various changes, substitutions and alterations can be made hereto without departing from the spirit and scope of the invention as defined by the appended claims.

CLAIMS

1. A photo-oxidation instrument for a water treatment system in a semiconductor device fabrication process, comprising:

a UV lamp for irradiating ultra violet radiation having a certain wavelength in order to oxidize organic materials contained in the water which is pre-treated;

a photo-oxidation part comprising the UV-lamp, and an inlet and an outlet for water flow; and

a catalyzing part provided on an inside wall of the photo-oxidation part in order to activate oxidation of the organic materials during irradiation of the UV radiation having a certain wavelength.

2. The photo-oxidation instrument of claim 1, wherein the UV lamp irradiates UV radiation of 185 nm wavelength.

3. The photo-oxidation instrument of claim 1, wherein the UV lamp irradiates UV radiation of 254 nm wavelength.

4. The photo-oxidation instrument according to any preceding claim, wherein the photo-oxidation part comprises a plurality of UV lamps.

5. The photo-oxidation instrument according to any preceding claim, wherein the catalyzing part is made of TiO_2.

6. The photo-oxidation instrument according to any preceding claim, wherein the catalyzing part is provided on the inside wall of the photo-oxidation part spaced from parts thereof.

7. The photo-oxidation instrument according to any preceding claim, wherein the surface of the catalyzing part is coated with polymer film.

8. A water-treatment system for use in a semiconductor device fabrication process comprising:

a pre-treatment unit comprising a sand filter for receiving water and precipitating the floating materials contained therein;

a reverse osmosis unit comprising a filter for receiving the water which is pre-treated and removing the ions and the organic materials contained in the water by using reverse osmotic pressure;

a gas treatment unit comprising a vacuum filter for receiving the water from which ions and organic materials are removed, and removing O_2 or CO_2 etc. gases contained in the water by using a vacuum;

a first photo-oxidation unit comprising a UV lamp for irradiating UV radiation, a photo-oxidation part containing a plurality of UV lamps, and a catalyzing part made of TiO_2 and provided on an inside wall of the photo-oxidation part for activating the oxidation of the organic materials, the first photo-oxidation unit receiving the water passing through the gas removal unit and oxidizing the organic materials contained in the water by using UV radiation of a certain wavelength;

[illegible] wall of the [illegible] organic materials, [illegible] passing through the [illegible] contained in the [illegible]

[illegible] unit comprising an ion-exchange resin for [illegible] containing the oxidised organic materials from the [illegible] and removing the ions contained in the water by [illegible]

a particle treatment unit comprising a filter for receiving the water passing through the ion-exchange unit and filtering the particles remaining in the water.

9. The water-treatment system of claim 8, wherein the pre-treatment unit further comprises an activated carbon filter for improving the muddiness of the water.

10. The water-treatment system according to claim 8 or claim 9, further comprising a first temporary storage tank for temporarily storing the water between the reverse osmosis unit and the gas treatment unit; and

a second temporary storage tank for temporarily storing the water between the first ion-exchange unit and the second photo-oxidation unit.

11. The water-treatment system according to any of claims 8 to 10, wherein the first photo-oxidation unit comprises a UV-lamp for irradiating UV radiation of 185 nm wavelength or 254 nm wavelength.

12. The water-treatment system according to any of claims 8 to 11, wherein the second photo-oxidation unit comprises a UV-lamp for irradiating UV radiation of 185 nm wavelength.

13. A water treatment method in a semiconductor device fabrication process comprising the steps of:

a) pre-treating the water for improving the precipitation of the floating materials contained in the water to be used in the fabrication process, and the muddiness of the water;

b) carrying out a first water-treatment comprising reverse osmosis treatment for removing organic materials and ions contained in the received water from the pre-treatment, gas treatment for removing gas such as O_2 or CO_2 etc., photo-oxidation treatment for irradiating the water with a certain wavelength of UV radiation and using a catalyst of TiO_2, and ion-exchange treatment by ion exchange, the above treatment steps being carried out in sequence such that the water passing through the pre-treatment is received in the first water treatment and the organic materials or ions in the water are treated; and

c) carrying out a second water-treatment comprising photo-oxidation treatment for irradiating the water with a certain wavelength of

UV radiation and using a catalyst of TiO_2, ion-exchange treatment using ion-exchange, and particle treatment for removing particles, the above steps being carried out in sequence such that the water passing through the first water treatment is received in the second water treatment and the organic materials or ions in the water are treated.

14. The method of claim 13, wherein in the first water treatment the wavelength of the UV radiation is 185 nm or 254 nm.

15. The method according to claim 13 or claim 14 wherein in the second water treatment the wavelength of the UV radiation is 185 nm.

16. A photo-oxidation instrument for a water-treatment system in a semiconductor device fabrication process substantially as described herein with reference to and as illustrated by Figures 2 to 7 of the accompanying drawings.

17. A water-treatment system substantially as described herein with reference to and as illustrated by Figures 2 to 7 of the accompanying drawings.

18. A method for water treatment substantially as described herein with reference to and as illustrated by Figures 2 to 7 of the accompanying drawings.

The Patent Office

Application No:	GB 9814978.4	**Examiner:**	E Quirk
Claims searched:	1-7	**Date of search:**	29 September 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): H5R(RBF, RBU)

Int Cl (Ed.6): C02F (1/32)

Other: Online:WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2 252 707 A	(Tioxide Group Sevices)Page 2 lines 4-11, Page 6 line 18 to page 7 line 2	1-6
X	WO96/36565 A1	(Photo-Catalytics) Whole Document	1-6
X	WO94/19284 A1	(Anatel Corp.) photocatalytic rods 58, UV lamp 64	1-6
X	US 5 516 492	(Clearflow Inc.) Whole Document	1
X	US 5 069 885	(Ritchie) Whole Document	1

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